

Form PTO-1390 (REV 11-98)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	<div style="border: 1px solid black; display: inline-block; padding: 2px;"> 1007 R-1201/PTO 1-5 MAR 2002 </div>
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>			ATTORNEY'S DOCKET NUMBER 6900-14  US APPLICATION NO (If known, see 37 CFR 1.5) <div style="font-size: 1.5em; font-weight: bold;">10/088429</div>
INTERNATIONAL APPLICATION NO. PCT/NL00/00659	INTERNATIONAL FILING DATE 18 September 2000	PRIORITY DATE CLAIMED 17 September 1999	
TITLE OF INVENTION METHOD OF SEPARATING PARTICLES IN A FLUID MEDIUM AND AN APPARATUS THEREFOR			
APPLICANT(S) FOR DO/EO/US REM, Peter Carlo, FRAUNHOLCZ, Norbert Otto, and DE BRUIJN, Arnoldus Johannes Matthijs.			
<p>Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:</p> <ol style="list-style-type: none"> <li>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</li> <li>4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</li> <li>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) <ol style="list-style-type: none"> <li>a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</li> <li>b. <input type="checkbox"/> has been transmitted by the International Bureau.</li> <li>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US)</li> </ol> </li> <li>6. <input type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2))</li> <li>7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</li> <li>b. <input type="checkbox"/> have been transmitted by the International Bureau.</li> <li>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li>d. <input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li>8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li>9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). <b>UNSIGNED</b></li> <li>10. <input checked="" type="checkbox"/> A copy of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol> <p><b>Items 11. to 16. below concern document(s) or information included:</b></p> <ol style="list-style-type: none"> <li>11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</li> <li>12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li>13. <input checked="" type="checkbox"/> A FIRST preliminary amendment.  <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</li> <li>14. <input type="checkbox"/> A substitute specification.</li> <li>15. <input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li>16. <input checked="" type="checkbox"/> Other items or information: 2 Return receipt postcards</li> </ol>			

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INTERNATIONAL APPLICATION NO  
PCT/NL00/00659ATTORNEY'S DOCKET NUMBER  
6900-14

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17. [X] The following fees are submitted:

**BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):**

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO.....\$1040.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO..... \$890.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO..... \$740.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$710.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$100.00

**ENTER APPROPRIATE BASIC FEE AMOUNT =****CALCULATIONS** PTO USE ONLY

\$890.00

Surcharge of \$130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	20-20 =	0	X \$18.00	\$ 0.00	
Independent claims	4-3 =	1	X \$84.00	\$ 84.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			\$280.00	\$ 0.00	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$974.00	
Reduction by 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				-\$0.00	
<b>SUBTOTAL =</b>				\$974.00	
Processing fee of \$130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.429(f)).				\$	
<b>TOTAL NATIONAL FEE =</b>				\$974.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$ 0.00	
<b>TOTAL FEES ENCLOSED =</b>				\$974.00	
				Amount to be refunded:	
				Charged	\$

a. [X] A check in the amount of \$ 974.00 to cover the above fees is enclosed.b. [ ] Please charge my Deposit Account No. 50-0951 in the amount of \$ .00 to cover the above fees. A duplicate copy of this sheet is enclosed.c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-0951. A duplicate copy of this sheet is enclosed.**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

J. Rodman Steele, Jr.  
Akerman, Senterfitt & Eidson, P.A.  
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SIGNATURE

J. Rodman Steele, Jr.  
NAME25,931  
REGISTRATION NUMBER

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: REM et al.

Application No.

Examiner:

Filed: (Herewith)

Group Art Unit:

International Application No. PCT/NL00/00659

For: METHOD OF SEPARATING PARTICLES IN A FLUID MEDIUM AND AN  
APPARATUS THEREFOR

PRELIMINARY AMENDMENT

Box Patent Applications  
Commissioner for Patents  
Washington, D.C. 20231

Sir:

Prior to examination on the merits, please amend the above-identified  
application as follows:

IN THE CLAIMS:

1           4. (Amended)           Method according to claim 1, characterized in that the fluid  
2 medium is an aqueous medium.

1           6. (Amended)           Method according to claim 4, characterized in that the  
2 aqueous medium has a temperature of about 0°C.

1           7. (Amended)           Method according to claim 1, characterized in that separate  
2 discharge-facilitating particles are present in the fluid medium.

1           9. (Amended)           Method according to claim 1, characterized in that the  
2 barrier for restraining the particles is an element provided in the separation chamber.

1           10. (Amended)           Method according to claim 1, characterized in that the  
2 element for restraining the particles comprises passages for the passage of the fluid  
3 medium.

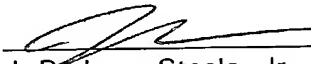
1           11. (Amended)       Method according to claim 1, characterized in that the  
2 element is provided at an angle with the horizontal, preferably at an angle between 2 -  
3 45°, more preferably between 5 - 30° such that the particles are transported

REMARKS

The foregoing Preliminary Amendment is made to present alternative definitions of the invention. No new matter is added. Examination on the merits is respectfully requested.

Respectfully submitted,

Date: 3/15/02

  
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Docket No. 6900-14

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: REM et al.

Application No.

Examiner:

Filed: (Herewith)

Group Art Unit:

International Application No. PCT/NL00/00659

For: METHOD OF SEPARATING PARTICLES IN A FLUID MEDIUM AND AN  
APPARATUS THEREFOR

ATTACHMENT TO PRELIMINARY AMENDMENT SHOWING MODIFICATIONS

Box Patent Applications  
Commissioner for Patents  
Washington, D.C. 20231

Sir:

In accordance with 37 CFR §1.121, the amendments made to the application  
are as follows:

IN THE CLAIMS:

1            4. (Amended)            Method according to [any of the preceding claims] claim 1,  
2            characterized in that the fluid medium is an aqueous medium.

1            6. (Amended)            Method according to claim 4 [or 5], characterized in that  
2            the aqueous medium has a temperature of about 0°C.

1            7. (Amended)            Method according to [any of the preceding claims] claim 1,  
2            characterized in that separate discharge-facilitating particles are present in the fluid  
3            medium.

1            9. (Amended)            Method according to [any of the preceding claims] claim 1,  
2            characterized in that the barrier for restraining the particles is an element provided in

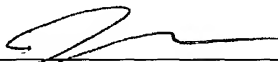
1 the separation chamber.

1 10. (Amended) Method according to [any of the preceding claims] claim 1,  
2 characterized in that the element for restraining the particles comprises passages for  
3 the passage of the fluid medium.

1 11. (Amended) Method according to [any of the preceding claims] claim 1,  
2 characterized in that the element is provided at an angle with the horizontal, preferably  
3 at an angle between 2 - 45°, more preferably between 5 - 30° such that the particles  
4 are transported

Respectfully submitted,

Date: 3/15/02

  
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Docket No. 6900-14

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**WO 01/21317 A1**

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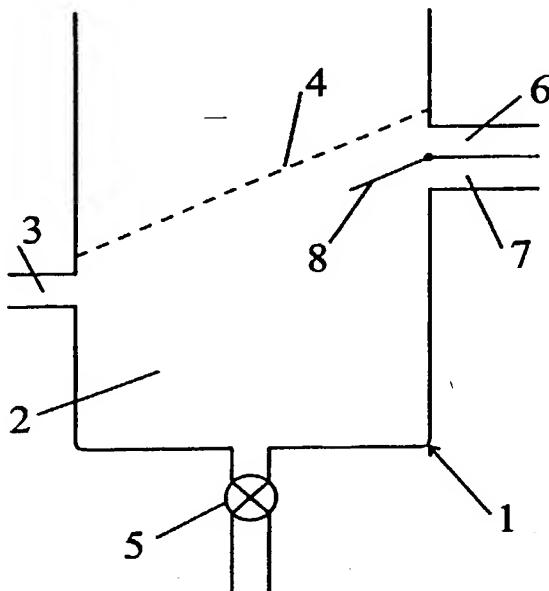
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- (81) **Designated States (national)**: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
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- Published**:  
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**Published:**

— *With international search report.*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

- (54) Title: METHOD OF SEPARATING PARTICLES IN A FLUID MEDIUM AND AN APPARATUS THEREFOR



**(57) Abstract:** The invention relates to a method of separating particles in a fluid medium, wherein the particles have a density lower than that of the fluid medium. According to the invention the particles are subjected to an up and down moving flow of the fluid medium, whereby a barrier is present above the particles restraining said particles. It appears that with the method according to the invention a particle separation can be performed in a cost effective and quick manner. The invention is in particular suited for the separation of plastics, such as polyethylene and polypropylene. The invention also relates to an apparatus suitable for performing the method.

**WO 01/21317 A1**

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Method of separating particles in a fluid medium and an apparatus therefor

The present invention relates to a method of separating particles in a fluid medium having a density higher than that of the particles to be separated, whereby a mixture of the particles to be separated is fed to a separation chamber of a separation apparatus, and streams enriched in a particular type of particles are discharged from the separation chamber.

The use of a fluid medium for the separation of a mixture of particles in two or more fractions is generally known. When the particles have a specific density lower than that of the fluid medium, such a separation is not very easy. It is known in the art to use centrifugation in order to increase the effect of the difference in density between the types of particles. This technique is expensive and often results in an unsatisfactory separation.

The object of the present invention is to provide a method wherein mixtures comprising different types of particles can be separated adequately.

To this end, the method according to the present invention is characterized in that the mixture of particles is subjected to a treatment comprising the step of moving the fluid medium up and down relative to the mixture of particles, whereby a barrier is present above the particles for restraining the particles.

Surprisingly it has been found that moving a mixture of particles having a density lower than that of the fluid medium up and down relative to said fluid medium (also known as "jigging") may effect stratification to achieve a separation. Jigging has been known for decades but not for the separation of particles having a density lower than that of the surrounding fluid medium. The mixture may comprise, for example, cork or wood. It may also be a mixture derived from domestic refuse. The barrier present for restraining the particles may be the face of the fluid medium. A stream enriched in particles of a particular type comprise the fluid medium

The use of aqueous media and in particular water, which are very cheap fluid media, does not result in contamination of the streams enriched in a particular type of particles and do not discharge volatile organic compounds (or just to a reduced extent). When using an aqueous medium such as water for the separation of plastics, care should be taken that the particles are well wetted by the fluid medium in or-

der to prevent adherence of air bubbles (which cause a false change in the density of the particle). This may be accomplished using friction-washing with the fluid medium or by adding low concentrations of surfactants. It is also possible  
5 to perform the method under elevated pressure (as a result of which any air bubbles present dissolve), or under reduced pressure (resulting in larger air bubbles which can more easily escape, after which the method is preferably again performed at ambient pressure).

10 According to an important embodiment, the aqueous medium has a temperature of about 0°C.

At this temperature the ratio of the densities of plastics to be separated, such as polyethylene and polypropylene, is maximal.

15 According to an important embodiment, separate discharge-facilitating particles are present in the fluid medium.

The presence of facilitating particles may be of particular importance when the composition of the mixture  
20 varies. By placing a partition substantially in the middle of the layer of the facilitating particles, the achievement of an optimal separation may be ensured. The facilitating particles may be separated from a stream enriched with a particular type of particles by any suitable means, such as the use  
25 of magnetism if the facilitating particles are ferromagnetic. Of course, facilitating particles recovered will be fed back into the separation chamber.

In this manner the separation of two types of particles may be optimised. It is also conceivable that more layers of facilitating particles are formed between (for example  
30 three) different types of particles.

Preferably the facilitating particles are bulky particles having a density between the densities of the streams enriched in particular particles.

35 This embodiment is very advantageous when the particles to be separated are flakes. The bulky particles will experience an effective density of its surrounding determined by both the density of the fluid medium and the particles

present. The different shape of the particles to be separated on the one hand and the facilitating particles on the other, makes it very easy to separate the facilitating particles from a stream enriched in a particular type of particle. The bulky facilitating particles may have a largest size similar to that of the largest particles to be separated, but its thickness will be significantly more than that of the particles to be separated, such as at least five times more. Advantageously the bulky particles are, for example, approximately spherical particles, cylindrical particles or polygonal bodies such as cubes etc.

Preferably an element provided in the separation chamber is used as the barrier for restraining the particles in the separation chamber.

Such an element makes it easy to generate the up and down moving flow of fluid medium while causing a minimal disturbance of particle layers already partially separated.

Preferably the element for restraining the particles comprises passages for the passage of the fluid medium.

As such an element a sieve or grating is suitable, the openings of which will suitably, be smaller than the smallest particles of the mixture.

Preferably the element is at an angle with the horizontal, preferably at an angle between 2-45°, and more preferably between 5-30°, 5-20° being most preferred, such that the particles are transported away from the supply opening. This aids in the transport of the particle layers in the separation chamber.

The invention also relates to a device suitable for separating particles having a density lower than that of the fluid medium.

Such an apparatus is characterized in that the apparatus comprises a separation chamber having a supply opening for particles to be separated and an element provided above the supply opening for restraining said particles, which apparatus is further provided with means for moving a fluid medium up and down relative to the particles to be separated.

Using such an apparatus makes it possible to achieve

an efficient separation of the particles in a cheap and simple manner. The element and the means for moving the fluid medium up and down may be the same, that is a sieve (or screen).

5 Preferably the element comprises openings for the passage of a fluid medium.

Such an element may suitably be a sieve of grating, of which the openings will suitably, be smaller than the smallest particles of the mixture.

10 According to a preferred embodiment, the element is provided at an angle with the horizontal, preferably at an angle between 2-45°, more preferably between 5-30°, 5-20° being most preferred, such that the particles are transported away from the place where they are supplied.

15 The invention also relates to an apparatus suitable for separating particles having a density lower than that of a fluid medium.

This apparatus is characterized in that the apparatus comprises a separation chamber having a supply opening  
20 for the particles to be separated said supply opening extending in a substantially radial direction and an element is provided above the supply opening, said element comprising a multitude of openings allowing the passage of said particles, first means are provided to move the fluid medium up and down  
25 relative to the particles to be separated and second means are provided to rotate the element relative to fluid medium in the separation chamber.

In operation, the mixture of particles to be separated will be supplied below facilitating particles. The element and the fluid medium may be rotated at the same speed  
30 (and in the same direction), allowing a very simple separation operation. The particles with higher density which do not pass the barrier consisting of the facilitating particles may be removed from the separation chamber, for example together with the facilitating particles. The facilitating particles can be separated from the particles with higher density by any conventional method, such as separation by size,  
35 using magnetic fields etc.

According to an interesting embodiment, the apparatus comprises means for locally disturbing a mass comprising added particles not capable of passing through the openings of said element and particular particles separated from particles which have passed through said openings of said element.

Thus it is possible to use the element to separate the facilitating particles from the particles having higher density. The means may comprise a pipe provided with a slit or number of nozzles from which fluid medium is ejected.

The invention also relates to a specific method of separating particles in a fluid medium having a density higher than that of the particles to be separated, wherein an apparatus according to the invention is used, a mixture of particles to be separated is supplied below a layer of facilitating particles having a thickness which doesn't allow them to pass through the openings of the element, the fluid medium in the separation chamber is rotated relative to the element, the element is moved up and down to move the fluid medium relative to the particles to be separated, causing particles with lower density to pass through the facilitating particles and through the openings in said element to end up in fluid medium above said element from which the particles are discharged from the separation chamber, whereas the facilitating particles act as a barrier for and restrain the particles with higher density, which particles with higher density are discharged from the separation chamber in the fluid medium below said element.

Preferably, the fluid medium is rotated with respect to the wall of the separation chamber.

According to an alternative method of separating particles in a fluid medium having a density higher than that of the particles to be separated, an apparatus according to an alternative embodiment of the invention is used, a mixture of particles to be separated is supplied below a layer of facilitating particles having a thickness which doesn't allow them to pass through the openings of the element, the fluid medium in the separation chamber is rotated relative to the



It has been found that it is advantageous to increase the resistance with which the fluid medium may flow through the passages of the sieve 4. This may be achieved, for example, by putting a layer of pebbles on top of the sieve 4.

5 If necessary, the mixture of particles to be separated is first subjected to a separation according to particle size, but the method according to the present invention is, in case of flake-shaped particles to be separated, surprisingly insensitive to the diversity of particle size in  
10 the mixture.

According to a very interesting embodiment particles to facilitate/separate discharge of different particles are present. According to a first embodiment, these particles will facilitate the division into separate streams of layers  
15 comprising a particular type of particle resulting from the separation. A partition can be placed in the layer of facilitating particles. This is much easier than determining the border between two layers comprising different particles. According to a second embodiment, the use of facilitating particles makes it possible to use a barrier having openings allowing the passage of the particles to be separated. For example and as schematically depicted in Fig. 3, the openings in sieve section 4a do not allow for the passage of particles. The screen section 4b allows for the passage of lower-  
20 density particles (which are discharged from the separation chamber 2 through outlet 13 shown in fig. 4), whereas higher-density particles, which are not capable of penetrating the layer of facilitating particles, will pass through openings in sieve section 4c and are discharged from the separation  
25 chamber 2 through outlet 14 (shown in fig. 4).

The apparatus shown in fig. 4 (top view) comprises a circular screen 4 (shown in part) which retains facilitating particles having density chosen such that they end up between particles having a relative low density and particles having  
35 a relative high density. The mixture of particles to be separated is supplied in a substantially radial direction through a supply tube 9 having a slit-like supply opening 3 or a multitude of supply openings 3 distributed over a substantial

part of the length of the supply tube 9. Both the screen 4 and the fluid medium in the separation chamber 2 are rotated counter-clockwise. This may be accomplished using a water jet. According to an alternative embodiment, the rotating  
5 screen 4 causes the fluid medium to rotate. To avoid a detrimental effect because of turbulence near the wall of the separation chamber, the screen 4 may be provided with circumferential, downward extending wall (not shown, but similar to fig. 3 near supply opening 3), the wall having a height  
10 larger than the length of stroke during operation.

In operation, particles having a lower density will pass through the layer of facilitating particles and through openings in the screen 4. A stream comprising fluid medium and particles having a lower density may be discharged from  
15 the separation chamber 2 from above the screen 4. The facilitating particles act as a barrier for the particles having a relatively higher density. The latter particles may be removed from below the screen 4 together with (a part of) the facilitating particles. Any facilitating particles present in  
20 a stream enriched in particles having a higher density may be separated using any conventional means, and will be fed back into the separation chamber 2 below the screen 4.

Alternatively, the screen 4 may be used to separate the denser particles from the facilitating particles by disturbing the strata (facilitating particles and denser particles). This may be easily achieved using pipes 12 provided  
25 with nozzles which supply fluid medium to disturb the subtle balance in the strata, causing the denser particles to go through the screen 4. In this case, two separate sections 10, 11 are provided above the screen 4. Both sections 10, 11 may  
30 move up and down together with the screen, but do not rotate. The first section 10 is used to collect particles having a lower density, the second section 11 is used to collect particles having a higher density.

35

#### Example 1

A mixture was prepared of 0.8 kg HDPE (white: density 945 kg/m<sup>3</sup>) and 0.2 kg PP (blue, density 900 kg/m<sup>3</sup>). The

grain size of both types of plastic was 1.7 - 4 mm. The apparatus used had a separation chamber with a volume of 3.1 litre and a diameter of 19 cm. Water was used as the fluid medium. To separate, the water was moved up during 1 second and  
5 down during 3 seconds in an asymmetric sinusoidal manner. The length of stroke was 9 cm. The stationary screen had passages of 0.5 mm square, with 100 passages per cm<sup>2</sup>.

Fig. 2 shows that despite the small difference in density a separation can be achieved very quickly. The pictures a - d were taken within a timespan of 2 min.  
10

#### Example 2

In this experiment, an apparatus as depicted in fig. 3 was used having a sieve 4 made of bars providing slit-like  
15 openings (width 6 mm, length several cm). Facilitating particles were used having a density of 970 kg/ m<sup>3</sup>, a length of 8-12 mm, a diameter of 8 mm and in an amount equivalent to two layers, to separate flakes of PP (density approximately 900 kg/ m<sup>3</sup>) and HDPE (density approximately 950 kg/m<sup>3</sup>). Condi-  
20 tions: frequency 10/minute; length of stroke: 45 mm; screen section 4a 300 mm, screen section 4b 50 mm. Screen width: 200 mm. Separation occurs in a period of 1-2 minutes. The PE obtained was almost pure (less than 1% PP). PP still comprised about 10% PE, which is still a significant improvement over  
25 the original 50/50.

10 10 2001

CLAIMS

(52)

1. Method of separating particles in a fluid medium having a density higher than that of the particles to be separated, whereby a mixture of the particles to be separated is fed to a separation chamber of a separation apparatus, and  
5 streams enriched in a particular type of particles are discharged from the separation chamber, characterized in that the mixture of particles is subjected to a treatment comprising the step of moving the fluid medium up and down relative to the mixture of particles, whereby a barrier is present  
10 above the particles for restraining the particles.

2. Method according to claim 1, characterized in that the particles to be separated are plastic particles.

3. Method according to claim 2, characterized in that the plastic particles to be separated are polyolefines.

15 4. Method according to any of the preceding claims, characterized in that the fluid medium is an aqueous medium.

5. Method according to claim 4, characterized in that the aqueous medium is water.

20 6. Method according to claim 4 or 5, characterized in that the aqueous medium has a temperature of about 0°C.

7. Method according to any of the preceding claims, characterized in that separate discharge-facilitating particles are present in the fluid medium.

25 8. Method according to claim 7, characterized in that facilitating particles are bulky particles having a density between the densities of the streams enriched in particular particles.

30 9. Method according to any of the preceding claims, characterized in that the barrier for restraining the particles is an element provided in the separation chamber.

10. Method according to any of the preceding claims, characterized in that the element for restraining the particles comprises passages for the passage of the fluid medium.

35 11. Method according to any of the preceding claims, characterized in that the element is provided at an angle

with the horizontal, preferably at an angle between 2 - 45°, more preferably between 5 - 30° such that the particles are transported away from the place of supply.

12. Apparatus suitable for separating particles having a density lower than that of a fluid medium, wherein the apparatus comprises

- a separation chamber having a supply opening for particles to be separated;
- discharge openings for separated fractions of particles;
- 10 - an element possessing passages provided above the supply opening, the element defining a first portion of the separation chamber and a second portion of the separation chamber;
- means for moving a fluid medium up and down relative to the particles to be separated,

15 characterized in that the element is a particles restraining element, and supply opening and the discharge openings are in direct communication with each other via the first portion.

13. Apparatus according to claim 12, characterized in that the element is provided at an angle with the horizontal, preferably an angle between 2 - 45°, more preferable between 5 - 30.

14. Apparatus suitable for separating particles having a density lower than that of a fluid medium, wherein the apparatus comprises

- a separation chamber having a supply opening for particles to be separated;
- discharge openings for separated fractions of particles;
- an element possessing passages provided above the supply opening, the element defining a first portion of the separation chamber and a second portion of the separation chamber;
- 30 - means for moving a fluid medium up and down relative to the particles to be separated,

35 characterized in that the element has a first section with first passages and a second section with second passages, the first passages being smaller than the second passages, the first section being a particles restraining element, a supply

opening and a first discharge opening being in direct communication with each other via the first portion, the supply opening and a second discharge opening being in communication with each other via the first portion, the second section and  
5 the second portion.

15. Apparatus according to claim 14, characterized in that the element is provided at an angle with the horizontal, preferably an angle between 2 - 45°, more preferable between 5 - 30.

10 16. Apparatus suitable for separating particles having a density lower than that of a fluid medium the apparatus comprises

- a separation chamber having a supply opening for the particles to be separated;
- 15 - an element provided above the supply opening, said element comprising a multitude of openings allowing the passage of said particles; and
- means provided to move the fluid medium up and down relative to the particles to be separated,

20 characterized in that said supply opening extends in a substantially radial direction and second means are provided to rotate the element relative to fluid medium in the separation chamber.

17. Apparatus according to claim 16, characterized  
25 in that it comprises means for locally disturbing a mass comprising added particles not capable of passing through the openings of said element and particular particles separated from particles which have passed through said openings of said element.

30 18. Method of separating particles in a fluid medium having a density higher than that of the particles to be separated, characterized in that an apparatus according to claim 14 is used, a mixture of particles to be separated is supplied below a layer of particles having a thickness which  
35 doesn't allow them to pass through the openings of the element, the fluid medium in the separation chamber is rotated relative to the element, the element is moved up and down to move the fluid medium relative to the particles to be sepa-

rated, causing particles with lower density to pass through the facilitating particles and through the openings in said element to end up in fluid medium above said element from which the particles are discharged from the separation chamber, whereas the facilitating particles act as a barrier for and restrain the particles with higher density, which particles with higher density are discharged from the separation in the fluid medium below said element.

19. Method according to claim 18, characterized in that the fluid medium is rotated with respect to the wall of the separation chamber.

20. Method of separating particles in a fluid medium having a density higher than that of the particles to be separated, characterized in that an apparatus according to claim 16 is used, a mixture of particles to be separated is supplied below a layer of particles having a thickness which doesn't allow them to pass through the openings of the element, the fluid medium in the separation chamber is rotated relative to the element, the element is moved up and down to move the fluid medium relative to the particles to be separated, causing particles with lower density to pass through the facilitating particles and through the openings in said element to end up in a first section comprising fluid medium above said element from which first section the particles are discharged from the separation chamber, whereas the facilitating particles act as a barrier for and restrain the particles with higher density, the means for locally disturbing the mass of facilitating particles and restrained particles with higher density, allowing said particles with higher density to pass through the openings in said element to end up in a second section above the element separated from the first section and discharging a stream enriched in particles having a higher density from the separation chamber.

[illegible]

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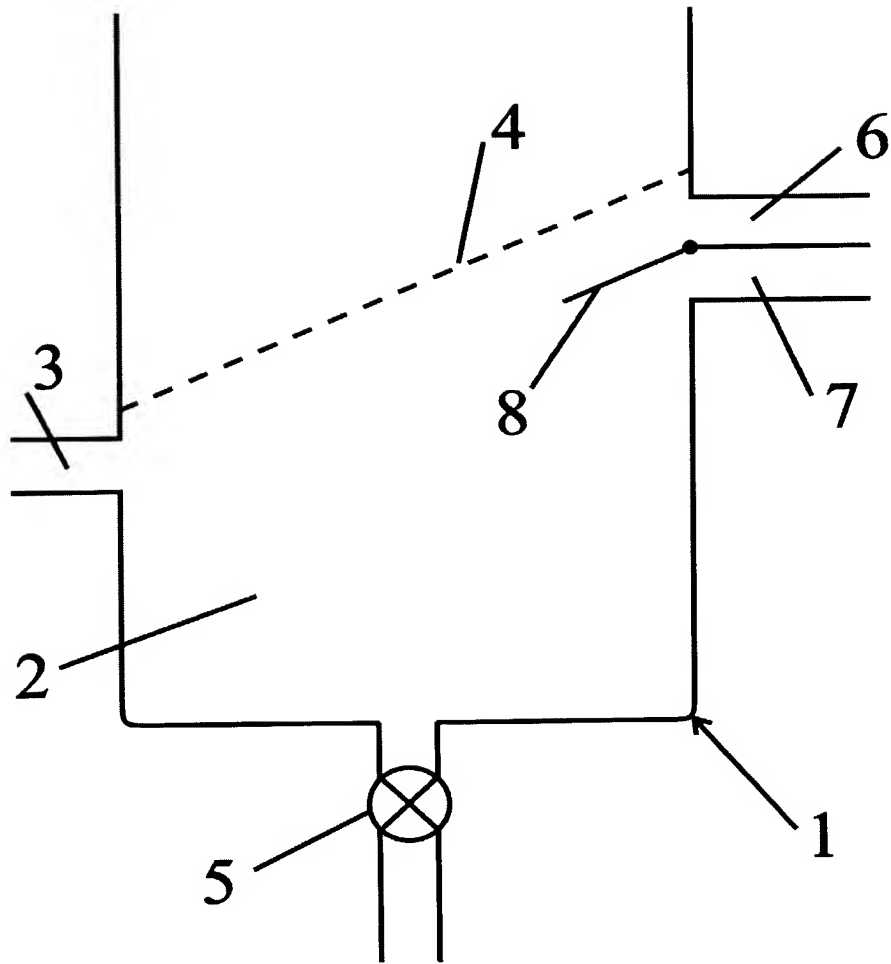
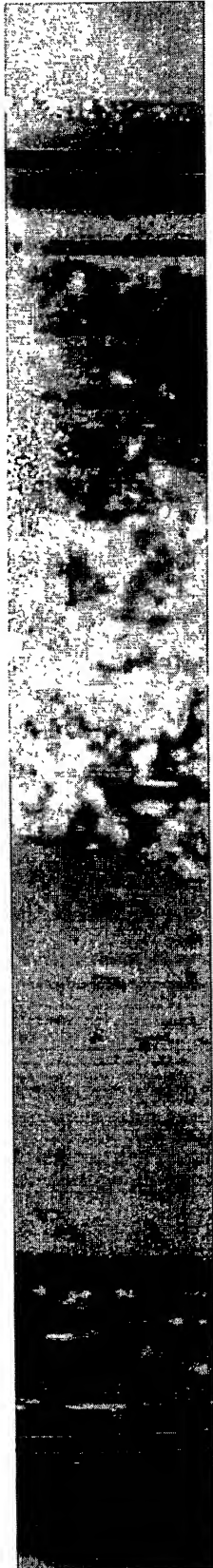


FIG.1

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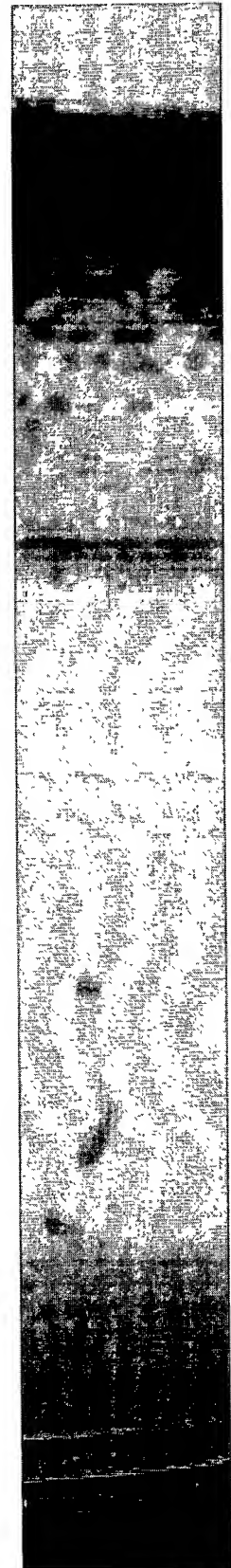
a



b



c



d

Fig. 2

Fig. 3

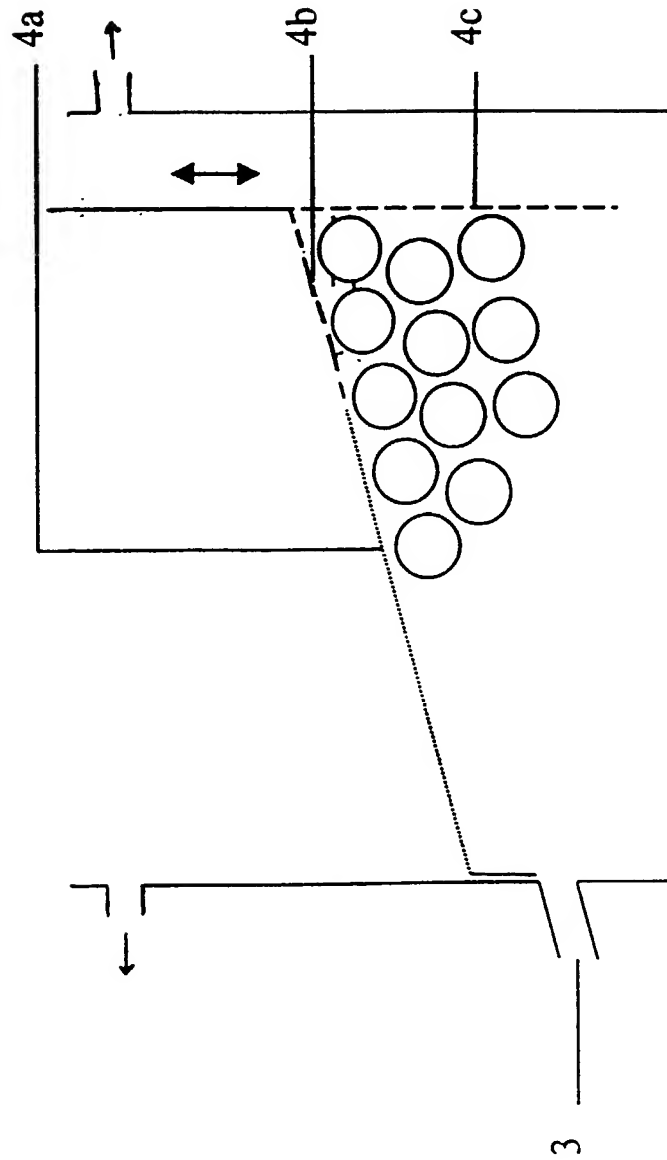
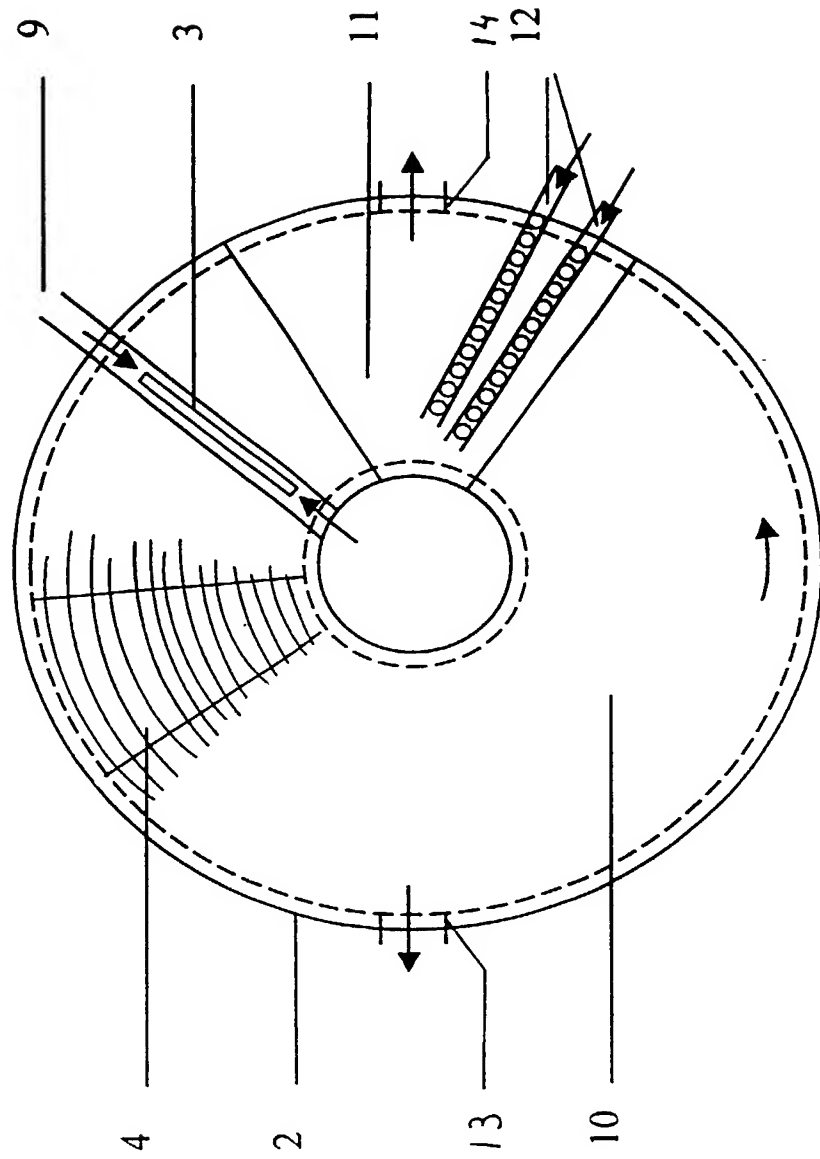


Fig. 4



**COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY**  
(includes Reference to PCT International Applications)

ATTORNEY DOCKET NUMBER

6900-14

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**METHOD OF SEPARATING PARTICLES IN A FLUID MEDIUM AND IN AN APPARATUS THEREFOR**

the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as U.S. Patent Application Serial Number \_\_\_\_\_  
on \_\_\_\_\_, as amended on \_\_\_\_ (if applicable).

☒ was filed as a PCT international application number PCT/NL00/00659 on 18  
September 2000, as amended under PCT Article 19 on \_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the applications for which priority is claimed:

**PRIOR FOREIGN PATENT APPLICATION(S) AND ANY PRIORITY CLAIMED UNDER 35 U.S.C. §119:**

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (Day, Month, Year)	PRIORITY CLAIMED UNDER 35 USC 119
NETHERLANDS	1013087	17 September 1999	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
NETHERLANDS	1015168	12 May 2000	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO

**COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY**  
(Includes Reference to PCT International Applications)
**ATTORNEY DOCKET NUMBER**  
**6900-14**

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

**PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:**

U.S. APPLICATIONS		STATUS (Check One)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	ABANDONED	PENDING

**PCT APPLICATIONS DESIGNATING THE U.S.**

PCT APPLICATION NUMBER	PCT FILING DATE	U.S. SERIAL NUMBERS			
PCT/NL00/00659	18 September 2000				

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201

*Peter*

DATE

March 6, 2002

SIGNATURE OF INVENTOR 202

*Frank*

DATE

March 6, 2002

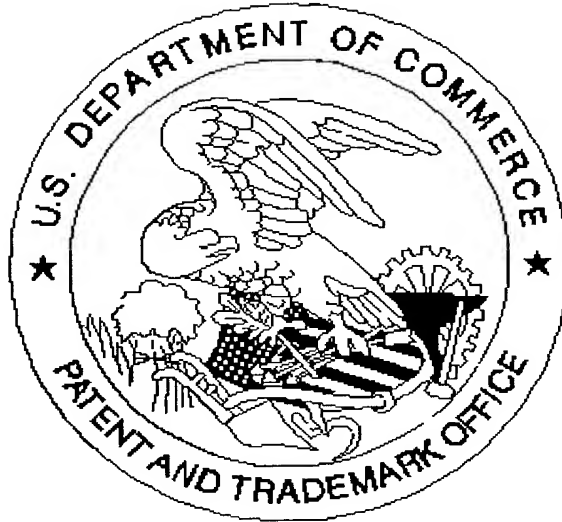
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*Arnoldus*

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